NEW MEXICO
Rio Puerco

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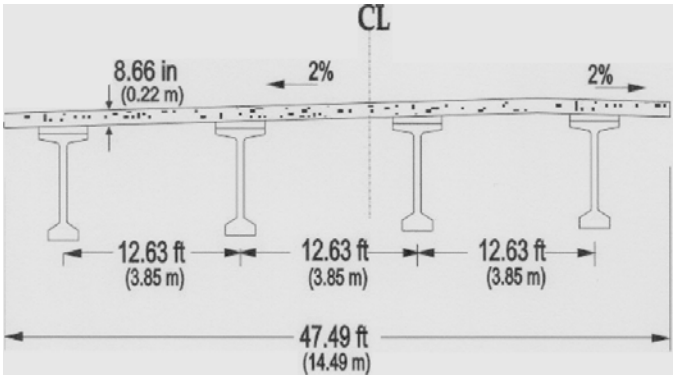
NEW MEXICO
Rio Puerco

1. DESCRIPTION



Location:	Old Route 66 over Rio Puerco
Open to Traffic:	December 2000
Environment:	Normal over water
HPC Elements:	Girders and deck
Total Length:	89.4 m
Skew or Curve:	None
Girder Type:	BT1600
Girder Span Lengths:	29.3, 30.8, and 29.3 m
Girder Spacing:	3.85 m
Girder Strand Grade:	270
Girder Strand Dia.:	0.5 in
Max. No. of Bottom Strands:	42
Deck Thickness:	220 mm
Deck Panels:	Stay-in-place steel panels

2. BENEFITS OF HPC AND COSTS

A. Benefits of HPC

The purpose of the project was to establish the viability of HPC in New Mexico. The project required the introduction of new construction methods and quality control requirements.

Cost comparisons based on preliminary designs showed that six lines of BT63 girders utilizing HPC would provide a superstructure cost savings of 7 to 10 percent compared to conventional strength concrete using eight lines of BT63 girders. The use of BT63 girders with HPC was estimated to provide a cost savings of 6 to 9 percent compared to the use of Type IV girders with HPC.

B. Costs

Bid Amount:	$2,963,195
Paid Amount:	$2,896,701

The material costs for HPC were 20 percent higher than conventional concrete resulting in an overall cost increase of about 10 percent.

3. STRUCTURAL DESIGN

Design Specifications:	AASHTO Standard Specifications for Highway Bridges, 1996 and Interim Specifications
Design Live Loads:	MS 18 (HS 20-44) and interstate alternative
Seismic Requirements:	—
Flexural Design Method:	—
Maximum Compressive Strain:	—
Shear Design Method:	—
Fatigue Design Method:	—
Lateral Stability Considerations:	—
Allowable Tensile Stress	
—Top of Girder at Release:	—
—Bottom of Girder after Losses:	—
Prestress Loss:	—
Method Used for Loss:	—
Calculated Camber:	Main span – 40 mm at release – 71 mm at erection Side span – 38 mm at release – 68 mm at erection
Concrete Cover	
—Girder:	25 mm to stirrups in web
—Top of Deck:	64 mm clear
—Bottom of Deck:	33 mm clear
—Other Locations:	—
Properties of Reinforcing Steel	
—Girder:	AASHTO M 31M/M Grade 420 epoxy coated if projecting into deck
—Deck:	AASHTO M 31M/M Grade 420 Top layer – epoxy coated Bottom layer – uncoated
Properties of Strand	
—Grade and Type:	AASHTO M 203, Grade 270, low relaxation
—Supplier:	—
—Surface Condition:	—
—Pattern:	26 straight strands 16 draped strands
—Transfer Length:	—
—Development Length:	—

4. SPECIFIED ITEMS

A. Concrete Properties

	Girders	Deck
Minimum Cementitious Materials Content:	—	—
Max. Water/Cementitious Materials Ratio:	—	—
Min. Percentage of Fly Ash:	—	—
Max. Percentage of Fly Ash:	—	—
Min. Percentage of Silica Fume:	—	—
Max. Percentage of Silica Fume:	—	—
Min. Percentage of GGBFS:	—	—
Max. Percentage of GGBFS:	—	—
Maximum Aggregate Size:	—	—
Slump:	—	≤ 9 in
Air Content:	—	4.5-9.0%
Compressive Strength		
—Release of Strands:	48 MPa	
—Design:	69 MPa at 56 days	41 MPa at 28 days
Chloride Permeability: (AASHTO T 277)	—	—
ASR or DEF Prevention:	—	—
Freeze-Thaw Resistance:	—	—
Deicer Scaling:	—	—
Abrasion Resistance:	—	—
Other:	—	—

B. Specified QC Procedures

Girder Production	
Curing:	—
Internal Concrete Temperature:	—
Cylinder Curing:	—
Cylinder Size:	—
Cylinder Capping Procedure:	—
Cylinder Testing Method:	—
Frequency of Testing:	—
Other QA/QC Requirements:	—
Deck Construction	
Curing:	Fogging, curing compound, saturated burlap, and polyethylene sheeting for 14 days
Cylinder Curing:	—
Cylinder Size:	—
Flexural Strength:	—
Other QA/QC Requirements:	Test slab 13.6x9.2 m

5. CONCRETE MATERIALS

A. Approved Concrete Mix Proportions

	Girders	Deck
Cement Brand:	—	—
Cement Type:	—	I/II
Cement Composition:	—	—
Cement Fineness:	—	—
Cement Quantity:	846 lb/yd^3	687 lb/yd^3
GGBFS Brand:	—	—
GGBFS Quantity:	—	—
Fly Ash Brand:	—	Phoenix Cement
Fly Ash Type:	F	F
Fly Ash Quantity:	127 lb/yd^3	172 lb/yd^3
Silica Fume Brand:	—	—
Silica Fume Quantity:	68 lb/yd^3	—
Fine Aggregate Type:	—	—
Fine Aggregate FM:	—	2.77
Fine Aggregate SG:	—	2.53
Fine Aggregate Quantity:	953 lb/yd^3	1290 lb/yd^3
Coarse Aggregate, Max. Size:	—	1/2 in
Coarse Aggregate Type:	—	—
Coarse Aggregate SG:	—	2.67
Coarse Aggregate Quantity:	1446 lb/yd^3	1400 lb/yd^3
Water:	312 lb/yd^3	275 lb/yd^3
Water Reducer Brand:	—	—
Water Reducer Type:	—	—
Water Reducer Quantity:	—	—
High-Range Water-Reducer Brand:	—	Adva Flow
High-Range Water-Reducer Type:	—	F
High-Range Water-Reducer Quantity:	—	56.3 fl oz/yd^3
Retarder Brand:	—	—
Retarder Type:	—	—
Retarder Quantity:	—	—
Corrosion Inhibitor Brand:	—	—
Corrosion Inhibitor Type:	—	—
Corrosion Inhibitor Quantity:	—	—
Air Entrainment Brand:	—	Daravair 1000
Air Entrainment Type:	—	Saponifed Rosin
Air Entrainment Quantity:	—	8.6 fl oz/yd^3
Water/Cementitious Materials Ratio:	0.30	0.32

B. Measured Properties of Approved Mix

	Girders	Deck
Slump:	7.5 in	7.25 in
Air Content:	7.2%	7.0%
Unit Weight:	137.5 lb/ft^3	137.9 lb/ft^3
Compressive Strength:	9474 psi at 14 days	5955 psi at 7 days 7873 psi at 28 days 9341 psi at 56 days

6. CONCRETE MATERIAL PROPERTIES

A. Measured Properties from QC Tests of Production Concrete for Girders

Cement Composition:	—
Actual Curing Procedure for Girders:	Steam
Average Slump:	—
Maximum Girder Temperature:	—
Air Content:	—
Unit Weight:	—
Compressive Strength:	7325 psi at 3 days 9076 psi at 28 days 10,151 psi at 56 days
Curing Procedure for Cylinders:	—

B. Measured Properties from QC Tests of Production Concrete for Deck

Cement Composition: —
Actual Curing Procedure for Deck: Per specification
Slump: 65-215 mm
Air Content: 4.5-8.2%
Wet Unit Weight: 2139-2403 kg/m^3
Compressive Strength:

Set No.	Compressive Strength, psi		
	7 days	28 days	56 days
Bridge Deck			
1	5458	6777 7029 6979	—
2	4889	5780 5714 5841	—
3	4958	5941 6009	7417
4	4508	5261 5222	6693
5	4957	5750 5718	7161
6	5160	6059 6286	8087
7	5196	6482 6295	7949
8	5406	6526 6395	7696
Bridge Deck and Diaphragm			
1	4961	5947 6105	—
2	5460	6430 6626	—
3	5109	6262 6283	—
4	5326	6182 6248	—
Average	5116	6160	7501

Curing Procedure for Cylinders: —

C. Measured Properties from Research Tests of Production Concrete for Girders

Not available.

D. Measured Properties from Research Tests of Production Concrete for Deck

Not available.

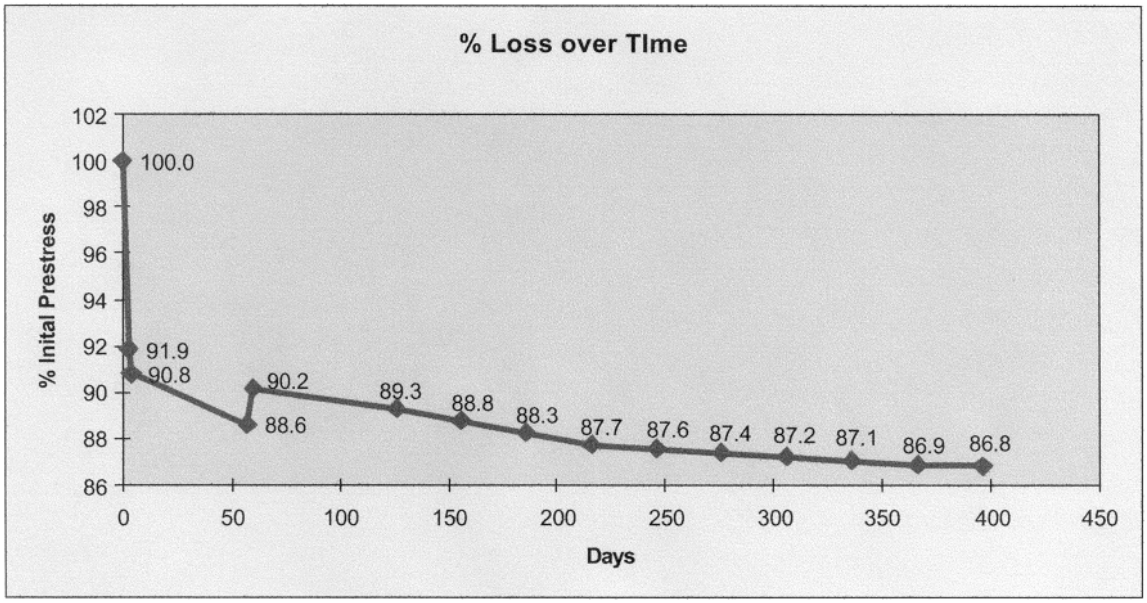
7. OTHER RESEARCH DATA

Coefficient of Thermal Expansion:

Age, days	Coefficient of Thermal Expansion (1), millionths/^{o}C
7	12.5
31	12.7

(1) Average values determined from strain and temperature measurements on the beams.

Prestress Losses:



Average Prestress Loss

See Excel spreadsheet for data

Camber:

Beam No.	Camber at Release, in
AC	1.56
AW	1.81
BC	1.63
BW	1.88

See section 10 for beam locations.

8. OTHER RELATED RESEARCH

Not available.

9. SOURCES OF DATA

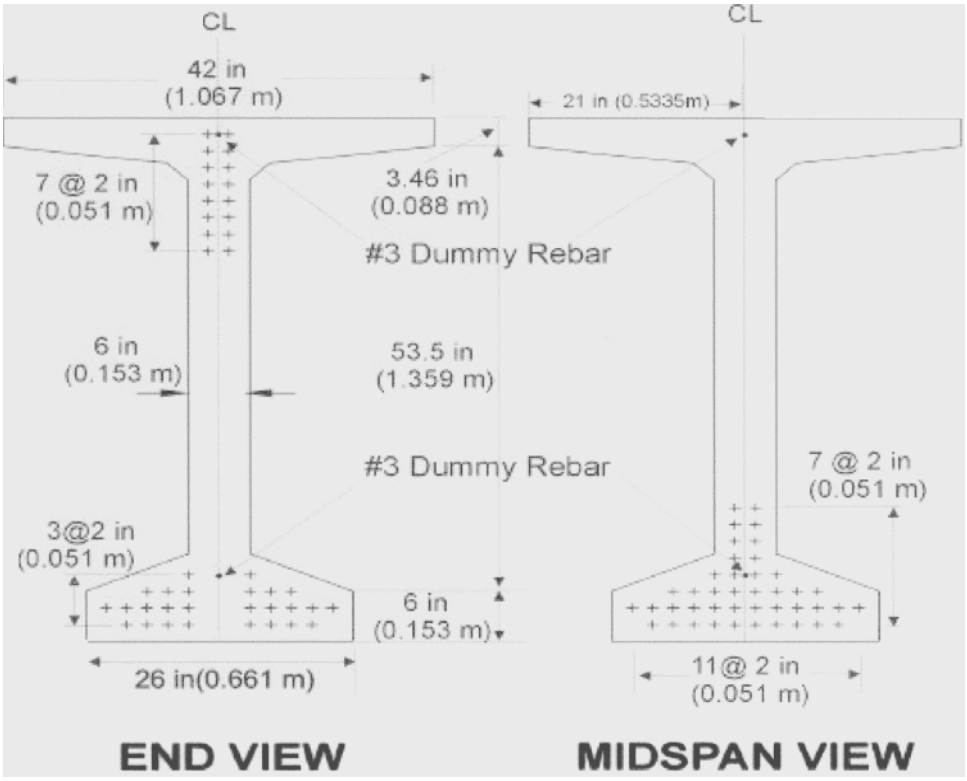
Idriss R. L. and Solana, S., "The Rio Puerco Bridge: Monitoring Prestress Losses in a High Performance Concrete Bridge with a Built-In Fiberoptic Sensor System," Research Report for New Mexico State Highway and Transportation Department, New Mexico State University, May 2002, 77 pp.

Peterson, S., "HPC Comes to New Mexico," *HPC Bridge Views*, Issue No. 25, January/February 2003, pp. 3.

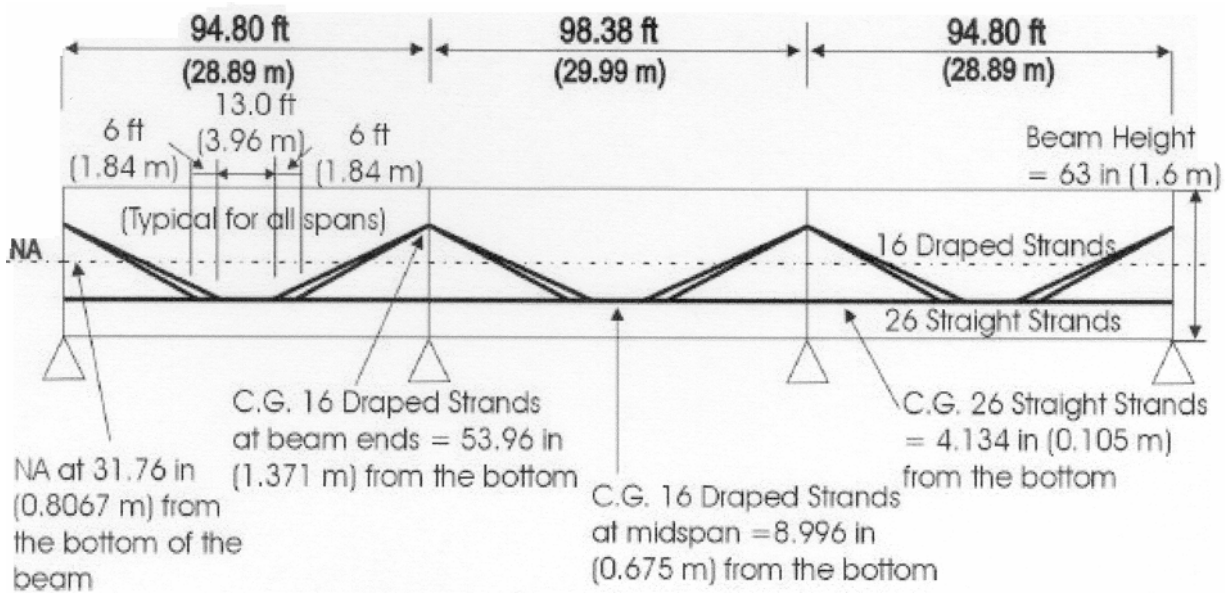
Sherman R. Peterson, New Mexico State Highway and Transportation Department, Santa Fe, New Mexico.

Bryce P. Simons, New Mexico State Highway and Transportation Department, Santa Fe, New Mexico.

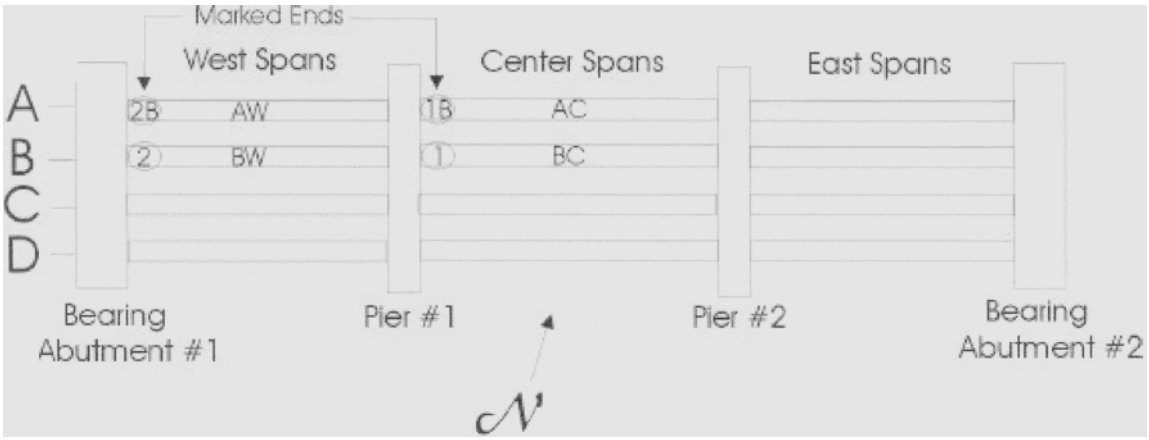
10. DRAWINGS



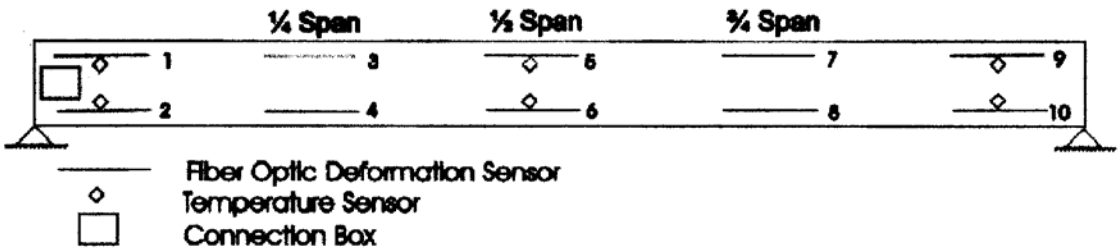
Cross-Sectional View of BT 1600 I-Beam



Side View of Beam Showing Prestressing Strand Profile



Locations of Instrumented Beams



Strain Sensor Locations

11. HPC SPECIFICATIONS

BR 0-7501 (10) CN2041
July 13, 1999

NEW MEXICO STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
SPECIAL PROVISIONS FOR
HIGH PERFORMANCE CONCRETE
SECTION 512-A

All provisions of the New Mexico State Highway and Transportation Department's Standard Specifications for Highway and Bridge Construction shall apply in addition to the following:

1.0 DESCRIPTION.

For this project, High Performance Concrete (HPC) is defined as the concrete in the cast-in-place deck and the prestressed concrete beams for the Rio Puerco Bridge. The work shall consist of furnishing, placing, curing, and testing the HPC in accordance with these special provisions, and the notes and details shown on the Plans and on the approved shop drawings. All requirements contained in section 512-Superstructure Concrete shall be applicable where appropriate.

3.0 MATERIALS.

Materials used in this construction shall meet the requirements of the Standard Specifications for Highway and Bridge Construction and these special provisions. The contractor is responsible for selecting the proper proportions to meet these special provisions, the placement conditions, and methods of placement.

3.1 CONCRETE MIX DESIGN.

All requirements detailed in Section 510 of the Standard Specification for Highway and Bridge Construction shall apply for this HPC concrete with the following change:

3.2 The laboratory compressive strength shall be at least 9.7 MPa greater than specified in the plans.

4.0 QUALITY ASSURANCE FOR HIGH PERFORMANCE CONCRETE.

The contractor shall submit the proposed concrete design to the Central Materials Lab for all classes of HPC used in this project.

4.1 The HPC for the cast-in-place deck shall be substantiated at least two months prior to deck construction. At least two trial batches with permissible combination of cementitious materials shall be prepared and test specimens shall be cast by the contractor and tested by the Central Materials Lab for permeability and strength.

4.2 The contractor shall demonstrate his ability to place the deck concrete by pouring, finishing, and curing a test slab as indicated on the plans, with the required project specifications. The test slab as called for on the plans shall be constructed using the same equipment (including a wind break and fogging system) and the same personnel used on the cast-in-place deck pour. The contractor will be paid for the first test slab only. If test results from the test slab are not approved by the Central Materials Laboratory, the Contractor will be required to construct additional test slabs at the contractor expense until test results are approved by the Central Materials Laboratory. The contractor shall remove and replace the test slab if the Project Manager deems it necessary. Any costs associated with the removal and replacement of the test slab shall be considered incidental to HPC.

4.3 No high performance concrete will be allowed to be placed on the project until the Central Materials Laboratory has approved the field trial.

5.0 WEATHER.

No high performance concrete shall be placed if the evaporation potential, as determined by Figure 512 in Section 512 of the Standards Specifications for Highway and Bridge Construction is in excess of 0.73 kg of water/square meter/hour. The evaporation potential shall be determined prior to fogging and outside the wind protection.

6.0 Immediately after the concrete has been placed, the concrete shall be protected to reduce or eliminate pre-mature evaporation from the surface of concrete. A windbreak and fogging system will be in place at least 24 hours prior to pouring the test slabs or deck.

6.1 WIND BREAK.

A windbreak with a minimum height of 2.43 m shall be constructed on a minimum of two sides immediately upwind at a minimum distance of 7.62 m from the area to receive the concrete. The nature and type of windbreak to be used shall be approved b the Central Materials Laboratory prior to placement of any high-performance concrete.

6.2 FOGGING SYSTEM.

A water fog shall be continuously applied over the surface of the freshly placed concrete in such a manner that the entire surface is kept at a relative humidity of 90% or greater. The area to be fogged shall be the entire area of the freshly placed concrete, which has not had the final finish applied. This fog shall be delivered through a network of nozzles, which are properly spaced to provide a uniform fog at the surface of the concrete. The nozzles used shall be of the type, which atomizes the water so that there are no visually discernible droplets of water. The area of coverage from each nozzle shall overlap all adjacent coverages by at least 12 inches. It shall be demonstrated prior to the placement of the concrete that the intended system is capable of delivering the required fogging environment for at least twice the anticipated required time. The intended system must be properly field tested, and approved by the Central Materials Laboratory before being used on High Performance Concrete. Fogging shall continue until the surface is covered with wet burlap. The wet burlap shall not be applied until the deck can receive the wet burlap and any placement loads without deformation.

6.3 MONO-MOLECULAR FILM (MMF).

The MMF system shall not be permitted on this project.

7.0 CURING.

All high performance concrete shall be cured for a minimum of 14 days in accordance with the following procedures:

7.1 Immediately following the application of the final finish, the concrete shall be completely and comprehensively covered with an approved curing compound.

7.2 Following application of the curing compound, the concrete shall be covered immediately with saturated burlap.

7.3 The saturated burlap will be immediately covered with a polyethylene sheeting material, which is at least 10 mils thick. This sheeting material shall be applied in such a manner that all joints are overlapped by the adjacent sheet by at least 24 inches. All joints shall be immediately covered with duct tape. The sheeting material used shall be completely free from any holes, tears, or other openings. If any openings are discovered they shall be immediately sealed with a permanent sealing method which is acceptable to the Project Manager.

7.4 The entire deck shall be re saturated every day during the curing period. If it is noticed during the curing period that the burlap is drying out, the source of moisture loss shall be immediately determined and closed. The burlap shall be re-saturated, and re-covered, and allowed to cure for the remainder of the required period.

7.5 During the curing period, there shall be no traffic, other than foot traffic, allowed upon this concrete for any reason.

8.0 RESEARCH ACTIVITIES.

The contractor shall cooperate with Department personnel, or their appointed agent, in research activities associated with this project by providing information and test specimens as requested. The contractor shall permit access to the site for the purpose of instrumenting the bridge. Instrumentation in the beams, abutment backwalls, diaphragms over the piers and/or the bridge deck will be used to gather data. It is anticipated that the instrumentation can be installed concurrently with the contractor's work, however, some delays to the contractor may occur. These occasional delays shall not be grounds for claims or contract time extensions. The contractor will need to keep the Department informed of the schedule of all High Performance Concrete activities, so that the instrumentation work will not cause any unanticipated delays.

9.0 SHOP PLANS.

Shop plans shall be prepared and submitted for approval of the BT-1600 prestressed concrete beams as per **Subsection 541.331 Shop & Erection Drawings**. Minor mounting hardware and notes will need to be added for instruments. The bridge design section will coordinate and approve shop plans, mounting hardware, and notes.

10.0 BASIS OF PAYMENT.

Payment will be in accordance with the Specifications and these special provisions. Use of silica fume as a partial cement replacement shall not be measured and paid for separately. All costs associated with the use of silica fume and fly ash shall be included in the unit price bid for concrete.

Payment will be made under:

Pay Item	**Pay Unit**
High Performance Concrete (HPC)	cubic meter
Wind Break (HPC)	L.S.
Fogging System(HPC)	L.S.
Prestressed Concrete Bridge Member Type BT-1600 (HPC)	meter